

DIMENSIONS

NBS

The magazine of
the National Bureau
of Standards,
U.S. Department
of Commerce

January 1977

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COMMENT

Science, Technology, and Effective Communication

The affluence, health, and security of the individual and the nation depend on the wise use of science and technology. Awareness of this fact is increasing. Industry is concerned about the necessity and cost of regulations that require technological changes. Economists worry that the nation's industries are losing their competitive edge in both domestic and international markets. Public interest groups are becoming more active in advocating the humane application of science. Consumers want more information about the performance of products. And there is a significant trend toward the use of technology-oriented diplomacy on the international level.

I have mentioned these few examples to make a point: Industry, the universities, the public—in a word, the nation—need better technical information, measurement methodology, standards, and data. These are the outputs of the National Bureau of Standards, an institution dedicated to the development of science and technology, working in support of government, industry, and the universities.

NBS' role is to maintain the scientific competence and objectivity necessary to help the nation make effective and humane use of technology. The hundreds of research projects carried on in our laboratories are directed toward these goals. And while the Bureau has a history of technical achievements and an outstanding scientific reputation, we see the opportunity for more numerous contributions in the future. Our facilities in

Gaithersburg, Md., and Boulder, Colo., are staffed by scientists and engineers who represent a broad range of technical disciplines and serve one of the most diverse clienteles of any laboratory in the world.

In short, we are ready today, as we have been since 1901, to meet the challenge of furthering the wise use of science and technology. We know that our effectiveness in putting NBS results to work is predicated on a single factor: good communication.

All of our research produces information. It is communicated to potential users through the more than 100 conferences and 40 traveling exhibits sponsored each year by the Bureau; through collaborative research projects with the academic and industrial communities; through legislative testimony, briefings, and speeches; and through more than 40,000 pages of published material a year.

Usually when we communicate using one or another of these methods, we speak to a particular segment of the Bureau's large audience. The Bureau's monthly magazine, DIMENSIONS/NBS, is the exception. Twelve times a year, we attempt to present NBS research, national issues, and directions in science and technology to the entire range of interested and affected parties.

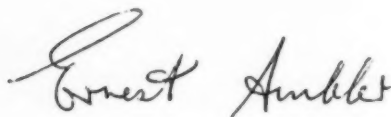
This issue of DIMENSIONS represents a major advance in the evolution of the magazine, and, consequently, in our continuing effort to improve communication.

In recognition of the diversity of the Bureau's audience and differing interests and needs, we have departmentalized the magazine, tailoring each section to a particular purpose.

For example, the articles in the front of the magazine are aimed at general audiences. In this issue, "Good Data, Bad Data?" is addressed to all scientists and laboratory managers in need of a readily available source of accurate quantitative information. Other articles should appeal to even broader audiences who care to be informed about metrication, computer technology, the environment, and how consumers can make themselves heard.

The *Staff Reports* section speaks in specialized terms to technical audiences about developments in the laboratory and the services offered by the Bureau. *On Line With Industry* highlights an area of NBS cooperation with industry which is geared toward public benefit. The *Standards Status* department looks at the thrust of some important NBS standards activities. The *Conferences and Publications* sections keep interested individuals up to date on these areas, and *News Briefs* contains timely items in capsule form.

It is our hope that readers with scientific as well as general interests will find useful information within the new format of DIMENSIONS/NBS. I invite you to take advantage of this opportunity each month to stay in touch with science and technology at the National Bureau of Standards.



Ernest Ambler
Acting Director

January 1977

DIMENSIONS

NBS

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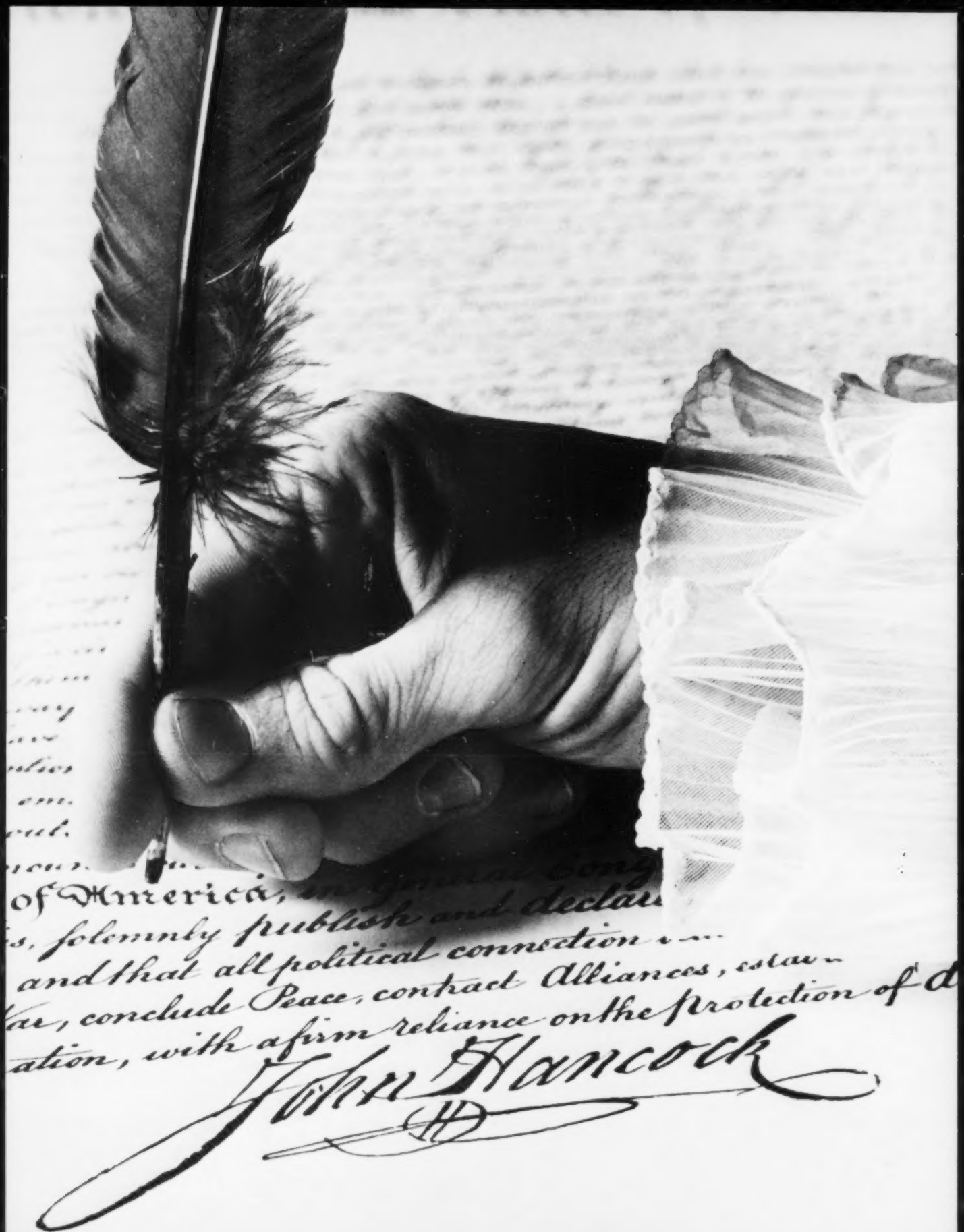
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of America, and solemnly publish and declare
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John Hancock

It is doubtful that King George III questioned the identity of the man who signed the Declaration of Independence so conspicuously. Today, however, a "John Hancock" can be used to verify a person's identity—as long as the individual "signs in" to a computer with an instrumented pen. This and other sophisticated techniques help prevent unauthorized use of computer systems.

by Paul Meissner*

IN this country, computer systems store and transfer information on every taxpayer. This function is only the very tip of a large iceberg involving massive stores of data and transfer not only of information but also of money.

To uphold our privacy laws and ensure the security of both information and funds, we need sophisticated techniques for verifying the identity of individuals who are authorized to use a computer system. But no matter how sophisticated the techniques become, they divide into three categories: Identity can be verified on the basis of something a person knows, something a person has, or something unique about a person.

Something a person *knows* could be a password, the combination to a lock, or a set of facts from his personal background (mother's maiden name, school teacher's name, places of residence, and so forth). Passwords are presently the most common form of information used to control access to computer terminals. Something a person *has* could be a key, an ID card, or a credit card. Something *about* a person could be a physiological attribute, such as fingerprints, handwriting, voice, or the lengths of his fingers. Various other features having distinctive patterns have been considered, such as the face, ears, teeth, and retina

* Meissner is a computer systems engineer in the NBS Institute for Computer Sciences and Technology.

of the eye. Of course, people are most commonly recognized by their faces, but this form of identification is limited to situations in which a guard controls access to an area. There is also a serious question as to how well a guard can recognize an individual on the basis of a picture ID card if the individual is unknown to the guard.

Naturally, anything known to one individual could become known to another; thus if an unauthorized person learned the password to a computer system, he might gain access to the system to serve his own ends. Likewise, an object such as a key or credit card might fall into the wrong hands (or perhaps be counterfeited) and be used in an unauthorized manner. For these reasons, a great deal of emphasis is presently being placed upon the use of unique physiological attributes as a means of verifying identity.

Fortunately, the computer can be of great help in such verification. With the availability of small, inexpensive computers which are nevertheless capable of rapidly executing complex programs, it is possible to extract from a single but complex attribute a representative "reference profile." This reference profile may be compared through sophisticated matching and correlation routines with measurements of that physical characteristic obtained on future occasions. And a determination can be made as to whether these measurements are within an

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WILL THE REAL JOHN HANCOCK Please Sign In?

The Privacy Act of 1974 asserts that "the privacy of an individual is directly affected by the collection, maintenance, use, and dissemination of personal information by federal agencies." This law established stringent requirements for safeguarding such information within the federal government. The Institute for Computer Sciences and Technology is responsible for developing standards and guidelines on the implementation of the necessary safeguards.

Techniques for verifying the identity of authorized computer users can prevent would-be imposters from gaining access to the systems.

acceptable tolerance, thereby confirming or refuting the identity of the individual.

Typically, the reference profile is obtained by "training" a recognition system through an initial set of measurements, from which a set of averages and limits are obtained. With some systems, an adaptive process is included which enables the reference profile to follow a gradually changing attribute, such as might occur with aging. A variety of systems for this type of identity verification are presently being developed in response to the growing importance and need for more reliable, inexpensive, and convenient methods.

How do these methods work?

In general, an individual must first present a claimed identity to the recognition system. He might, for example, type his name or enter an assigned identification number. This provides the system with the information for retrieving the proper reference profile and preparing to carry out the verification process. The person then goes through a specified "ritual," such as signing his name with an instrumented stylus, speaking into a microphone, placing his hand or finger on a scanning device, or whatever is required. Signals corresponding to the measured attribute are thus produced and are analyzed by the system and compared with the reference profile.



This instrumented stylus is connected to a computer system. Here, the system is being trained to recognize the dynamics of Helen Wood's signature. The computer is building a reference profile of data consisting of the pressures used in the signing. In the future the computer will compare this reference profile with the dynamics of a signature being presented to it. If, indeed, it is Helen Wood who is signing in, the system will give an acceptance signal. If not, it will reject the imposter.

photos by Mark Helfer

If a match is obtained within a specified tolerance, the identity is considered to be verified. An acceptance signal can then be produced to allow the person to proceed with some authorized activity. If a match is not obtained, a rejection signal is produced. The person may then be given another opportunity to identify himself on the chance that the first attempt failed due to marginal operation. Usually not more than three attempts would be allowed in order to prevent an imposter from trying repeatedly in the hope of being accepted on the basis of chance.

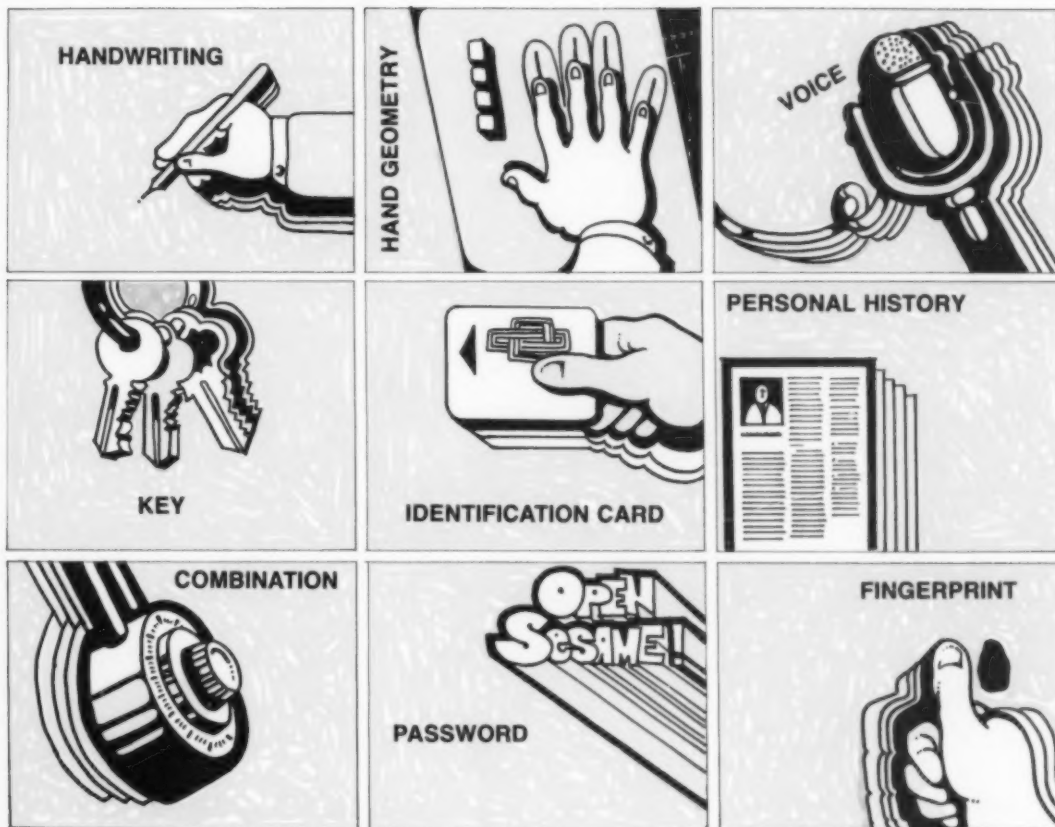
How do these recognition systems operate?

Recognition systems based on signatures make use of the dynamic features of the writing process (forces, velocities, accelerations) rather than the static signature image. These dynamic features are highly individualized and would be very difficult for a would-be impersonator to perceive or duplicate. It is interesting to note that the systems can be trained to perform recognitions on words other than the signature, although the signature is preferable since it is essentially a conditioned reflex action and is not under conscious control to the extent that an arbitrary word would be.

Of course, the person must be consistent in his choice of signature for this purpose. Many people have more than one signature, depending on whether they are signing formal documents, correspondence, or credit receipts. Any of these signatures could be used in training the system, but thereafter the person should use that same signature for verifying his identity.

When recognition is by voice, it is necessary for the person to speak into a microphone using words that have previously been entered into the system through a process in which the computer is conditioned to recognize the characteristic features of the person's voice. But a would-be impersonator might use a recording of the person's voice in an attempt at deception. To counter this threat, the system selects phrases at random, from a set of previously stored words. The selected phrases are delivered over a loudspeaker and the person must repeat them. The potential number of phrases is great enough that it would not be practical to use a recorder for reproducing the selected ones within the time available.

There are various ways for matching fingerprints automatically as a means of verifying identity. One method consists of performing an optical correlation between the live print and a file copy of the print. It is not necessary to resort to inked impressions



Part of the ICST computer security program involves the assessment of current techniques for verifying the identity of an individual.

for this process; a satisfactory image of the print can be obtained by placing the finger on a properly lighted prism. Another method is to scan the image and derive a digitized file of data representing the fingerprint "minutia." These are the distinguishing features such as the beginnings, endings, and branches that occur among the ridges which constitute the fingerprint. This file of minutia data can then be compared with a reference file by using software programs that match these minutia data.

Interestingly, the lengths of peoples' fingers have been found to vary enough to form the basis for a recognition system (hand geometry). This was discovered by the Air Force in measuring a large number of individuals to obtain data for making gloves. This phenomenon has been incorporated in a device which measures the distance from the tips of the fingers to the web between the fingers by using a motor-driven assembly of photocells. The measurement can be made in less than one second.

How well do these systems work?

There are two factors of particular interest in

judging the performance of a personal recognition device: How well does it recognize the correct person, and how well does it discriminate against imposters. The rejection of correct persons is expressed by the False Alarm Rate (FAR), while the passing of imposters is expressed by the Imposter Pass Rate (IPR). In practical systems there is generally a trade-off between these two rates and there is usually an adjustment by which one can be favored at the expense of the other. The amount of data is still quite limited, but FAR and IPR rates which are both in the range of 1 or 2 percent are being achieved and it may be possible to make one of the rates vanishingly small in some systems.

Computer security is made up of many elements, but the verification of individual identity is one of primary importance. Although the computer has opened up new possibilities for misappropriating resources and information, it has also, fortunately, provided us with a new class of techniques for verifying that a person is who he says he is. This capability can be used to establish safeguards so that we may continue to benefit from the many useful ways in which computers can serve us. □

Meeting a Measurement
Challenge in
ALASKA



photos courtesy
Alyeska Pipeline Service Company

NBS, NOAA Scientists Engage in the Study of Marine Environment In Preparation for Off-Shore Oil Development Around Alaska

by Madeleine Jacobs*

HELP WANTED: To work on complex study of the marine environment in Alaska. Must be willing to get up at the crack of dawn, fly into remote areas of Alaska, dig in icy water and mud for mussels and algae. Must be able to develop new methods for analyzing samples of sediment, tissue, and water for minute amounts of organic chemicals. Only experienced chemists need apply.

THIS help-wanted ad never appeared in any magazine or newspaper. But it's an apt description of the kind of work that a team of chemists from the National Bureau of Standards' Institute for Materials Research has been carrying out for the last three-and-a-half years for the National Oceanic and Atmospheric Administration (NOAA).

The purpose is to determine natural levels of hydrocarbons (the main ingredients of petroleum) in the Alaskan marine environment prior to development of the outer continental shelf and to the opening of the trans-Alaskan oil pipeline later this year. The much publicized pipeline will span nearly 1300 kilometers from Alaska's North Slope to the southern port of Valdez. When fully operational, it is expected to carry nearly 2 million barrels of crude oil a day to Valdez, where ocean-going tankers will pick up and transport the oil.

Collecting baseline data of the environment in the northeastern Gulf of Alaska and around the Prince William Sound where offshore oil exploration could begin in the future and where tanker activity is expected to be greatest affords scientists a unique opportunity to study and characterize a basically pristine ecological system. With this baseline data in hand, the Department of Interior's Bureau of Land Management (BLM) and NOAA will be able to monitor carefully any changes in the system due to offshore oil exploration and to pipeline and tanker activity. Of special interest will be changes in the concentration of hydrocarbons.

New Methods Needed

The Alaska study began in July 1973, according to Dr. Harry Hertz, one of the five principal investigators from NBS. "NOAA asked us to assist its scientists in developing methods to measure the very low levels of natural hydrocarbons expected to be present in the Alaskan environment," Hertz recalls. "We realized that the usual methods used to measure hydrocarbons wouldn't work. After all, we

would be trying to detect substances that might be present in concentrations at the parts-per-billion level, and the chemicals used in the usual techniques often introduce potential contaminants in the same or higher concentrations as the substances we would be attempting to measure."

Existing methods of hydrocarbon analysis also were not specific enough to permit single compound identification. And the samples had to be collected with minimal contamination. "It was crucial to collect the samples of sediment, water, and marine life in a way that introduced the least amount of potential contaminants," Hertz explains. Accordingly, Hertz and his colleagues, Dr. Stephen Chesler, Willie May, Dr. Barry Gump (who was on sabbatical from the California State University at Fresno), and Dr. Stephen Wise set out to develop an entire system that would overcome these problems. The job involved developing protocols or guidelines to follow in collecting and storing the specimens as well as devising methods for analyzing them once they were collected. The entire system would then serve as a prototype for the monitoring studies that would take place after the pipeline was in operation.

Sampling Crucial

To insure that the samples were collected properly, NBS researchers went to Alaska six times over the course of two years. Specimens were taken during every season except winter and involved water, sediment, mussels, and algae.

Virtually cut off from civilization, the researchers had to work under chilly, rainy conditions much of the time. They flew to remote sampling sites with bush pilots, always with the possibility of spotting

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Pipe storage yard at Valdez, the southern terminal of the trans-Alaska pipeline, as it appeared in 1971.

* Jacobs is a writer and public information specialist in the NBS Office of Information Activities.

a "downed plane" along the way. This aspect of the trip was especially disconcerting. "Despite the beautiful scenery, we were always aware of the dangers involved. Then once we arrived at the site, we had to pay very close attention to what we were doing," Hertz says.

For example, while collecting sediment, researchers wore rubberized rain gear. To minimize contamination from the rubber, all samples were gathered with personnel and equipment located so that the tidal wash was away from the sample. During the course of the project, the researchers also had to develop a special noncontaminating device that could collect water samples at a depth of 10 meters.

At each site, the researchers also measured the temperature, electrical conductivity, and salinity of the water. The specimens were frozen immediately and flown back to NBS laboratories in Gaithersburg, Maryland, where they were kept stored until ready to be analyzed. About 700 samples were collected.

Key to Project

A crucial element of the entire project involved designing analytical methods that could determine and identify the individual hydrocarbons. "The prime criterion was the development of a contamination-free procedure that minimized possible losses of samples," Hertz says. "The procedure had to involve as few transfers, as few solvents, and as few concentration steps as possible. The time involved in working with the materials after they thawed should be short—a matter of hours. The methods also would have to allow analysis of compounds having a wide range of molecular weights."

In the usual methods of analyzing hydrocarbons, a sample is first extracted with an organic solvent, the solvent is concentrated, and then an aliquot or small amount is analyzed by gas chromatography or gravimetric means. This procedure requires large amounts of a sample and also involves the use of organic solvents that can contain potential contaminants.

In the methods developed by the NBS researchers, only hydrocarbon-free water is used to analyze the tissue and sediment samples. Then, to remove hydrocarbons in the sample, purified nitrogen gas is blown over the surface of the sample which is dispersed and stirred in the water. This drives the organic molecules of interest out of the water and into the gas—or headspace—sitting above the water. This method is called "dynamic headspace sampling." The majority of the organic compounds to

lab photos by Mark Helfer



In the NBS laboratory, chemist Harry Hertz uses a computerized mass spectrometer to analyze organic compounds in tissue, sediment, and water samples.

be studied are removed directly from the headspace and analyzed by using a combination of methods, including gas chromatography, mass spectrometry, and liquid chromatography. Computers are utilized wherever possible to collect the maximum amount of data.

Quality Assurance

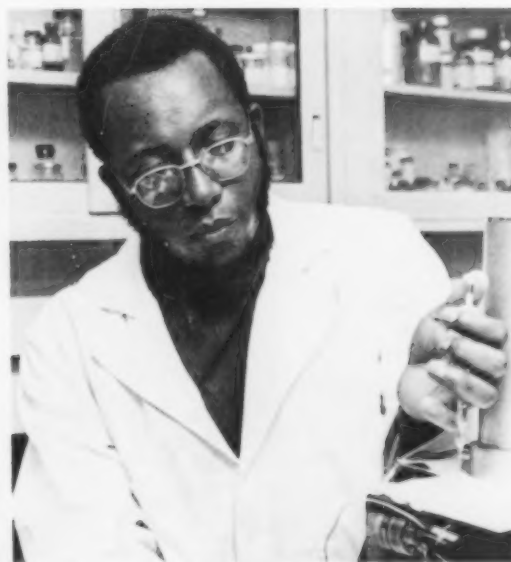
Using these methods, the chemists have been able to analyze hydrocarbons in the Alaskan samples at the parts-per-billion ($\mu\text{g/kg}$) level. All specimens were divided and analyzed in triplicate, Hertz notes. Controls were also run simultaneously to insure that no contamination was introduced into the sample. Most recently, the NBS team modified and improved the method used to analyze tissue samples from the marine life to eliminate non-hydrocarbon compounds that will interfere with the analyses.

With the tissue analyses completed, the baseline work is essentially finished. The NBS researchers have published* detailed accounts of how sampling, storage, and analysis should be carried out for the BLM-NOAA contractors who will be monitoring the areas after the pipeline begins operation later this year. NOAA is coordinating the entire Northeast Gulf of Alaska program under contract to the Bureau

* "Trace Hydrocarbons Analysis: The National Bureau of Standards Prince William Sound/Northeastern Gulf of Alaska Baseline Study," NBS Technical Note 889, U.S. Government Printing Office, Washington, D.C. 20402, \$1.80.



Top to bottom, NBS scientists Willie May and Harry Hertz and NOAA researcher Joyce Gnagy collect marine samples in Port Valdez. On the south shore of Port Valdez, research team collects mussels for later analysis. Map showing pipeline route.



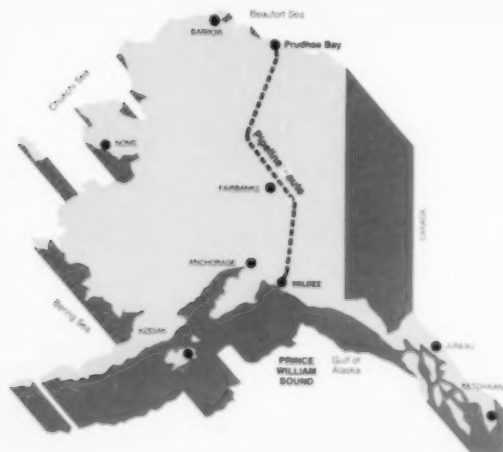
May injects a sample liquid chromatography column, one of the methods used to analyze marine samples for trace hydrocarbons.

of Land Management of the Department of Interior.

"Our prime function now is serving as a quality assurance laboratory for BLM-NOAA contractors," Hertz says. "In the absence of Standard Reference Materials and a single definitive method of analysis that could state what the levels of pollutants are, we're trying to determine the degree of interlaboratory precision." In this task, the researchers send out well characterized sediment and tissue samples for NOAA contractors to analyze and see how the results obtained by the individual methods compare with each other.

Outside Alaska

Meanwhile, the researchers have been extending their expertise in the area of hydrocarbon measurement into areas outside Alaska. For example, they've developed methods for analyzing polynuclear aromatic hydrocarbons—PAH's—which are suspected cancer-causing chemicals found in petroleum. They have also used their methods to monitor components in oil spills and hydrocarbons around oil refineries and have looked at ambient levels of hydrocarbons in the Atlantic Ocean. The team is now working on developing Standard Reference Materials for detecting trace concentrations of petroleum. The SRM's would be used in the calibration of instruments and methods for measuring small amounts of petroleum components which, in turn, would increase the precision and intercomparability of measurements among different laboratories. □



Utilizing Consumer Insight

by Frederick P. McGehan*

IT is a particularly muggy morning in early August. Seated around a long table in a conference room at the National Bureau of Standards in Gaithersburg, Md., are 13 people—10 women and three men. They are dressed in leisure clothes. To the uninitiated visitor it may appear to be another routine meeting to conduct business in a large government agency.

But it's not a routine meeting. In fact, only one person in attendance is an employee of the National Bureau of Standards. The others around the table are teachers, home economists, housewives, retirees, and a textile executive. There is animated conversation across the table and, occasionally, the man from the textile industry will pass garments around the table for the others to examine. They are interested in reading the care labels attached to the fabrics.

The scene is a regular meeting of a consumer sounding board, a unique voluntary organization designed to provide consumer input to the nation's voluntary standards-making process. The National Bureau of Standards, along with four other groups, sponsors a network of twelve such boards across the country. Basically, they provide standards-makers with the direct grassroots opinions of those who use the standardized products—the consumers.

On this particular morning, Braham Norwick, vice president and technical director of Joseph Bancroft and Sons Company, has requested a "sounding" on the usefulness of care labels on clothing. He is acting in behalf of an American Society for Testing and Materials (ASTM) technical committee.

There is general agreement among the consumers present that they can no longer tell the type of fabric in a piece of clothing just by sight or feel because of the many synthetic fibers on the market. So care labels have become very important items.

The consumers have several complaints to register with Norwick. One is that many care labels are sewn into garments behind the wearer's neck. Often these labels itch and irritate the skin to the point that they are removed—thus defeating the purpose for which they were intended. "We're saying we want the care label on garments but we're cutting them off," says Katherine Rhodes, home extension agent for Montgomery County, Maryland.

* McGehan is a writer and public information specialist in the NBS Office of Information Activities.

The consumers are also concerned about a lack of explicit instructions on some care labels. "We want more specific information on the label, such as 'Do not dry-clean in coin-operated machine' instead of 'Do not dry-clean,'" states Mrs. Patricia Plitt, a housewife.

Following this discussion, Norwick passed around a brochure giving international symbols for care instructions. These symbols are already used in some European nations, and Norwick wanted to get the sounding board's reaction to their possible introduction into the United States. The group agreed that the use of symbols was a "good direction" in which to proceed but cautioned that the symbols should be absolutely clear. Patricia Tengel, a teacher, felt that a "no iron" label was ambiguous and should be changed to "Do not iron."

Later, Norwick had praise for the work of consumer sounding boards. He said he found them "very helpful" in obtaining grassroots input. He said he was afraid at first that the boards would be composed of "professional consumers" but that he had not found this to be the case.

"Professional juries are something I don't believe in; nor do I believe that decisive judgments about textile quality and value can be made only by the technical community. The people—the voters, the buyers, the true jury—need to be involved," Norwick said.

This was precisely the intention when Margaret Dana, a noted consumer consultant, proposed the idea of consumer sounding boards in 1973. Dana is a syndicated newspaper columnist and a member of a National Academy of Sciences' panel for evaluating the work of the Standards Applications and Analysis Division of NBS's Institute for Applied Technology.

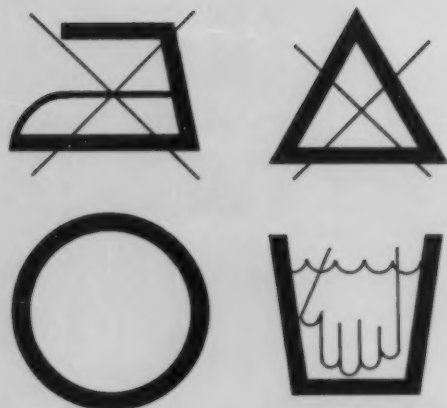
From 1972 to 1975 Dana served as a member of the board of directors of ASTM. It was during this period that she foresaw the need for consumer participation in the development of voluntary standards as a means to insure openness and credibility in this system.

The first consumer sounding board was formed in October, 1973, and is known as the Delaware Valley Consumer Sounding Board. It has some 60 consumers from Delaware, Pennsylvania and New Jersey as members or alternates, meeting on a monthly basis with from 18 to 24 members attending regularly.

From this beginning the concept was supported by NBS, ASTM, the American National Standards Institute (ANSI), National Fire Protection Association, and Underwriters' Laboratories, Inc. One of the first

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The first consumer sounding board was formed in October 1973 and is known as the Delaware Valley Consumer Sounding Board.



Some consumer boards have been "sounding" on the subject of how clothing should be labeled so that care instructions can be readily understood. Recommendations made by the boards are being forwarded to the Federal Trade Commission, the agency responsible for the regulation of care labeling. Other countries, including Canada, are trying a system of symbols instead of words to simplify communication and to avoid language difficulties. FTC currently requires that care instructions appear in English on all garments sold in the U.S., thus preventing the use of symbols without words.

The symbols shown here are included in a draft proposed by the International Standards Organization. This series of symbols (clockwise from top left) indicates that a garment should not be ironed or bleached but may be hand-washed or dry-cleaned.



"Professional juries are something I don't believe in; nor do I believe that decisive judgments about textile quality and value can be made only by the technical community. The people—the voters, the buyers, the true jury—need to be involved."
—Braham Norwick

meetings to acquaint consumer groups with the voluntary standards system and to encourage the formation of sounding boards was held at NBS in late 1973.

The National Bureau of Standards sponsored a series of meetings in the Washington, D.C., metropolitan area in 1974 to develop sounding boards. One result was an agreement by the Cooperative Extension Service to participate in a series of boards. The first NBS-affiliated board, for Montgomery County, Md., was launched in May 1975. It was followed by boards for Prince Georges County, Md., in June; Fairfax County, Va., in October; and Arlington County, Va., in February 1976.

The four boards in the Washington metropolitan area are the largest concentration of boards in any single locality. Other, single boards have been established in Nassau County, N.Y., Los Angeles and San Rafael, Calif., Boston, Chicago, Seattle, and San Francisco.

Eric Vadelund, a special assistant to the director of the Center for Consumer Product Technology, manages NBS' involvement in the growing consumer sounding board movement. NBS is interested in sounding boards, he notes, because the boards are dedicated to promoting and improving the voluntary standards system in this country. "We feel this is one way to get dialogue going (between standards writers and consumers) and to get consumer input," he notes.

The four NBS-affiliated sounding boards have been asked to comment and make recommendations on a variety of concerns. One of the first requests came from the Consumer Product Safety Commission (CPSC), which asked for consumer attitudes and opinions on poison-prevention packaging.

The Prince Georges County board discussed this at its inaugural meeting. Pleased with this initial effort, CPSC later granted ANSI \$10,000 to help expand the sounding board network.

Washington area boards have also been "sounded" on energy labels for home appliances and on safety questions involving ladders, air rifles, and lawnmowers. The boards discussed information contained on spray paint can labels and on terminology used to identify flammability characteristics of wearing apparel—as well as fabric care labels.

The board's recommendations are passed on to the organization that requested the "sounding." These groups include CPSC, ANSI, ASTM, and industry associations. The request for assistance on wording of paint can labels, for example, came from the Paints and Coatings Association.

Vadelund believes the boards are serving a valuable role in developing product information and standards that are meaningful to the consumer. "Basically we are responding to all critics who say the consumer is the forgotten soul in this [standards setting] process."

Sounding board members are not picked because they have technical competence. They are chosen, usually through the aid of the Cooperative Extension Service, because they represent the end-user of consumer products. They are expected to voice opinions and attitudes based on their experiences with consumer products. "If someone is technically competent in an area, then that's gravy," Vadelund notes. By all measures, the consumer sounding board concept has gotten off to a good start, is fulfilling a needed role in voluntary standards development, and should enjoy a bright future. □



Consumer Sounding Boards:

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COVER STORY:

Good Data Bad Data?

by Edward L. Brady*

The thermal conductivity of copper at room temperature is

- | | |
|--|--|
| <input type="checkbox"/> 1.52 W•cm ⁻¹ K ⁻¹ | <input type="checkbox"/> 3.48 W•cm ⁻¹ K ⁻¹ |
| <input type="checkbox"/> 3.31 W•cm ⁻¹ K ⁻¹ | <input type="checkbox"/> 4.01 W•cm ⁻¹ K ⁻¹ |

This is an imperfect world, and published results often differ enough to create considerable confusion.

No, that isn't a multiple-choice question from a freshman chemistry quiz. It is a real-life situation of the type faced by thousands of technical people every day. Each of the values was found in a reputable publication, and the question is which, if any, is "correct."

What resources do confused researchers have? There are several options:

- stop looking after finding one number
- average the various values
- select one from the group—and pray
- repeat the measure, a costly process that may or may not produce a more accurate value
- if the work had been done, find and use a standard reference data value. More about this later.

Numbers are the stepping stones between theory and practice, the communication link between laboratory and potential user. In the best of all possible

worlds, the numbers produced by measurements in one laboratory would agree closely with like measurements made in another. Unfortunately, this is an imperfect world, and published results often differ enough to create considerable confusion. Many factors contribute to these differences—inadequate calibration of instruments, poor characterization of materials, unsuspected sources of error, and sometimes just plain blunders.

The magnitude of what people frequently call the "publication pollution" problem is formidable. Over a million papers each year, in some 30,000 different journals, report the results of some measurement. Merely finding the work done in a particular area is a difficult task. And once a paper is located, there is an obvious question concerning the accuracy of the data. If the author has gone the second mile, providing details on his measurement method and apparatus, and on the estimated precision and accuracy of the results, the reader has a basis for making a value judgment. But all too often such information is omitted, making the results, which may be inherently quite accurate, difficult to evaluate.

Is there an answer to the dilemma? Yes, and like everything else these days there is some good news and some bad. The answer: *standard reference data*.

First, a definition: Standard reference data are "best values" that have been *critically evaluated* as to their reliability. Such best values are derived from

*Dr. Brady is associate director for information programs at the National Bureau of Standards.

an analysis of all the data in the literature by specialists expert in the field and skilled at the difficult task of making judgments as to the quality of the work that produced the data. These numbers can be recommended to users as the best values available.

The work of many data evaluators is coordinated and to some degree funded by the National Bureau of Standards, manager of the National Standard Reference Data System. So the good news is that data of high reliability are being made available. The bad news is that only a fraction of the literature is screened through the Standard Reference Data program at this time, and not enough scientists and engineers are aware of the existence of evaluated data.

The National Standard Reference Data System is a robust teenager, having been created in 1963. The system grew out of a recommendation, made by the Federal Council on Science and Technology, that NBS take on the primary responsibility within the federal government for critical evaluation of data in the physical sciences. Our mandate in this area was reinforced with passage of the Standard Reference Data Act in 1968.

Faced with a task of immense proportions and great urgency, NBS chose the only reasonable solution—we enlisted the aid of specialists around the world. Our approach has been to coordinate a series of data centers dealing with different fields of science. While some of these centers are within NBS—such as that on atomic transition probabilities headed by Dr. Wolfgang Wiese—many of them are not. For example, there is a data center on thermophysical properties at Purdue University, headed by Prof. Y. S. Touloukian, and other projects have been supported at dozens of universities, government institutions, and industrial laboratories.

Some of these centers are long-term projects funded by a variety of sources, while others are short-term projects aimed at solving a particular problem. The "average" data center, if such a center exists, systematically reviews the world literature in a particular field, evaluates the data, and publishes critical compilations of standard reference data. This can be an immense task, in light of the avalanche of technical papers published each year.

How does the seminal task of data evaluation take place? Data evaluators must certainly be expert in the various techniques used to measure the quantity

of interest and must be alert to sources of systematic error in the techniques. They should be aware of which labs have in the past done careful, accurate work; they should be skilled in analyzing the descriptions of measurement approaches and in evaluating what raw data are presented; and they must have that indefinable combination of 6th sense, perception, and suspicion that leads to judgments of real validity.

Active data collection and evaluation projects are underway which provide data needed for such applications as:

- Energy and environmental R & D
- Industrial process design
- Materials selection and development
- General support of research in the physical sciences.

These projects produce compilations of evaluated data, reviews of the state of quantitative knowledge in special areas, computations of functions derived from standard reference data, and bibliographies. Their outputs are published in a variety of forms, including formal monographs, magnetic tapes, and loose-leaf data sheets.

A special publication—the *Journal of Physical and Chemical Reference Data*—has been established by NBS, the American Institute of Physics, and the American Chemical Society. This journal, issued quarterly, serves as a major outlet for work performed by the Data Centers. Another vehicle is the National Standard Reference Data Series published by NBS, a series now containing over 50 titles.

If you would like more information on NSRDS, or if there are areas in which you feel a need exists for evaluated data, please contact us. The mailing address is

Office of Standard Reference Data
A537 Administration Building
National Bureau of Standards
Washington, D.C. 20234

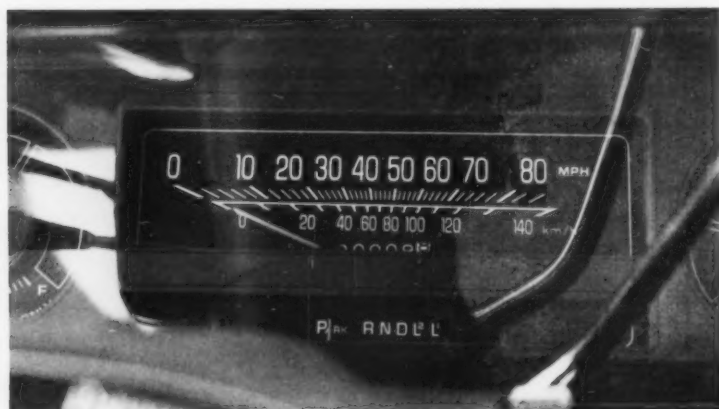
I almost forgot—the "best value" for the thermal conductivity of copper at 300 K is $4.01 \text{ W} \cdot \text{cm}^{-1} \text{K}^{-1}$.*

Not enough scientists and engineers are aware of the existence of evaluated data.

NBS has the primary responsibility within the federal government for the critical evaluation of data in the physical sciences.

* *Journal of Physical and Chemical Reference Data*, Vol. 3, 1974, Supplement No. 1, "Thermal Conductivity of the Elements: A Comprehensive Review," C. Y. Ho, R. W. Powell, P. E. Liley.

Transition to



The United States is shifting to the metric system of weights and measures. The transition shows increasingly in small ways, such as the growing number of daily temperature broadcasts in degrees Celsius and in large ways, such as the authorization of a U.S. Metric Board.

To provide perspective on how we got where we are, DIMENSIONS/NBS has asked Jeffrey Odom to provide the historical background.

by Jeffrey V. Odom*

THE Englishmen who settled the American colonies naturally brought their weights and measures with them. Unfortunately for us, those weights and measures were not a system but a hodgepodge of units that had been established over time by custom and royal edict. Our "inch," "foot," and "yard" have their origins in the ancient "digit," "palm," "span," and "cubit" of the Egyptians.

As English civilization developed and expanded, necessary relations between the various units were defined on an ad hoc basis. Sometimes this occurred in fascinating ways. Tradition holds that King Henry I decreed that the yard should be the distance from the tip of his nose to the end of his thumb. The length of a furlong (or furrow-long) was established by early Tudor rulers as 220 yards. This led Queen Elizabeth I to declare, in the 16th century, that henceforth the traditional Roman mile of 5000 feet would be replaced by one of 5280 feet, making the mile

exactly eight furlongs and providing a fairly convenient relationship between two previously ill-related measures. Thus England by the 18th century had achieved a greater degree of standardization than the continental countries. The English units were well suited to commerce and trade because they had been developed and refined to meet commercial needs. Through English colonization and dominance of world commerce during the 17th, 18th, and 19th centuries, the English weights and measures were spread to and established in many parts of the world.

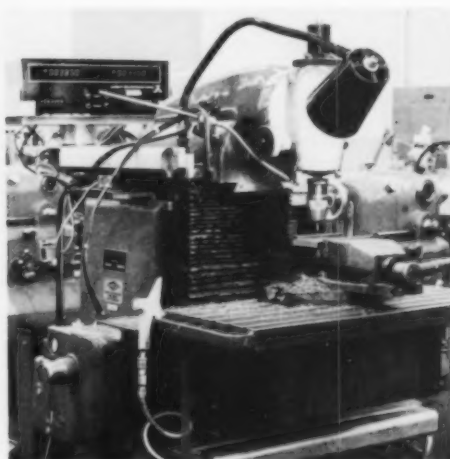
Since the industrial revolution started in England, it is not surprising that the English weights and measures came to dominate the design and engineering practice of much of world industry. This was in spite of their demonstrable inconvenience for scientific and engineering activities. With the United States' inheritance of world industrial domination from Britain in the 20th century, the "English"—now our customary—weights and measures have naturally seemed to us quite firmly established for commerce and daily life, and we have dealt with all of the messy conversions—inches to feet to yards to rods to miles, pints to quarts to gallons to barrels, square feet to acres, ounces (which kind?) to pounds—as an unavoidable inconvenience and friction in life.

Metric had its origin in 1790 when a commission of the French Academy of Sciences devised a plan for what came to be known as the metric system of weights and measures. This was a true system because it was based on three fundamental principles: 1) Use of a reproducible, natural constant as the basis for length, with the units for other quantities of weights and measures (for example, capacity,

Through English colonization and dominance of world commerce during the 17th, 18th, and 19th centuries, the English weights and measures were spread to many parts of the world.

*Odom, formerly head of the NBS Metric Information Office, is now helping the nation go metric through the NBS Office of Weights and Measures. He is also chairman of the Committee on Metric Conversion of Internal NBS Operations.

o 'Ametrica'



photos by Mark Helfer and David Sipple

mass) derived from it. 2) Only one (base) unit for the measurement of each quantity (for example, meter, gram, second). 3) Larger and smaller measures (multiples and submultiples) for convenience of use to be formed by ratios of 10 to 1, that is, a "decimal" system. The simple relationships between the units and decimal structure of the system commended its use for scientific work, and the international scientific community came to use metric measurements exclusively. As industrialization advanced outside Great Britain in the mid 19th century, the metric system gradually spread to become the predominant measurement language of industry and commerce in all the nations of continental Europe and in the non-English-speaking countries of Asia. The metric system was far superior to the wide variety of weights and measures units that had been in use.

Thus the first half of the 20th century saw the world of industry and commerce divided into two camps—metric and nonmetric. Measurement-induced frictions and incompatibilities of engineering standards separated the two sides. Gradually the balance shifted to the pro-metric side. This was illustrated dramatically in 1965 when the United Kingdom resolved to join the "metric tide," and the rest of the former Commonwealth countries followed soon after. The United States found itself high and dry with its legacy of irrational and complex "English" measures. Our worsening balance of trade situation seemed to be signalling to us that this legacy might be more than just a nuisance.

Scientific American once said in an editorial: "There exists no good reason at all why the meter-liter-gram system has not been adopted by the peo-

ple of the United States . . . except that deep-seated quality of human nature which causes us all to put our backs up and resist changes until they are forced on us. . . . Many American manufacturers, however, already are using the metric system of measurements today for the production of export articles. What remains to be done is . . . to convince the average man of the desirability of the change . . . to demonstrate to him that he should contribute his share to making the change."

That may sound pretty current, but the editorial appeared 50 years ago. However, the story of the U.S. involvement with the metric system is almost as old as the country itself.

Our Constitution logically gave Congress the power "to fix the standard of weights and measures." In his first message to the Congress, in 1790, President Washington addressed this matter again by saying, "Uniformity in the currency, weights, and measures of the United States is an object of great importance and will, I am persuaded, be duly attended to." This matter was referred to Secretary of State Thomas Jefferson, who was requested to prepare a suitable plan for consideration by the Congress.

Jefferson had heard of the metric system proposed to the French National Assembly, and his report (submitted to Congress in July, 1790) was somewhat delayed while he evaluated the French proposal. But he was apparently not much influenced by it. What most disturbed him about the French idea was the fact that the natural base for the meter, as originally defined, could be reproduced only in France. Thus other nations would either have to

Scientific American once said, "There exists no good reason at all why the meter-liter-gram system has not been adopted by the people of the United States . . . except that deep-seated quality of human nature which causes us all to put our backs up and resist changes . . ."

turn page



TRANSITION TO 'AMERICA' *continued*

trust the French results or take the trouble of sending people to France to verify them. Although he admired the courage with which measurement reform was advanced in France, he preferred his own idea of using a (reproducible) pendulum as the standard.

All of Jefferson's efforts came to naught, however, because the Congress failed to act on his proposals. In 1821, Secretary of State John Quincy Adams restudied the matter but again no action was taken.

The next major involvement of the United States with the metric system occurred in 1866 when the use of the system was made legal by act of Congress. Incidentally, the metric system is the only system so recognized, although it is certainly not illegal to use feet and inches. These are "legal" primarily because, by custom, they are widely used.

In 1875, the United States joined sixteen other countries in signing the Treaty of the Meter. This treaty set well-defined standards for length and weight, and established a permanent machinery to further refine standards. The standards were based on the metric system.

As result of the Treaty, the United States, in 1893, received its national standards for weights and measures from the International Bureau of Weights and Measures located near Paris. Since that time, our national standards have been metric. The yard and pound are legally defined as fractions of the meter and the kilogram.

From the close of the 19th Century until the mid 1960's, there was virtually no official action by the U.S. government in the field of metrication. In the late 1890's, early 1900's, and the 1920's, the Congress gave thorough consideration to metric conversion legislation. None was ever approved.

In 1968, after a decade of serious questioning prompted by international trade issues and decisions by major trading partners to "go metric," the Congress moved by enacting the Metric Study Act. It called on the Secretary of Commerce to "conduct

a program of investigation, research, and survey to determine the impact of increasing worldwide use of the metric system on the United States; to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; to study the feasibility of retaining and promoting the international use of dimensional and other engineering standards based on the customary measurement units of the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible for the United States."

The resulting U.S. Metric Study, carried out by a team assembled at the National Bureau of Standards with the guidance of a panel of private citizens representing a broad spectrum of interests, surpassed even John Quincy Adams' comprehensiveness. The team surveyed some 3000 manufacturing companies, almost 3000 firms of all other types, 700 groups (such as labor unions, trade associations, professional societies, education associations, and consumer-related organizations), 55 departments and agencies of the federal government, and some 1400 families to collect the information needed to answer the questions posed by the Congress.

Broadly, the Study found:

- that the United States had become an island in a world rapidly standardizing on metric measures—the only other countries not yet committed to going metric were a dozen small, developing nations
- that in certain activities the U.S. already made substantial use of the metric system, and that such use was increasing, especially where influenced by the standards activities of our multinational manufacturing companies
- that a broad consensus of those surveyed believed increased use of metric to be in the Nation's best interest (70 percent of manufacturers; 61 percent of nonmanufacturing companies; 74 percent



of those of the general public who were familiar with the metric system)

- that if more widespread use of metric was deemed a desirable goal, the way to get there was by national plan rather than by continued drift.

Forwarding this information to the Congress in the final report of the U.S. Metric Study, the Secretary of Commerce in July 1971 recommended: "That the United States change to the International metric system deliberately and carefully. . . . through a coordinated national program." More specifically, the Secretary recommended: "That the Congress assign the responsibility for guiding the change, and anticipating the kinds of special problems described in the Report, to a central coordinating body responsive to all sectors of our society; that within this guiding framework, detailed plans and timetables be worked out by these sectors themselves; that early priority be given to educating every American schoolchild and the public at large to think in metric terms; that immediate steps be taken by the Congress to foster U.S. participation in international standards activities; that in order to encourage efficiency and minimize the overall costs to society, the general rule should be that any changeover costs shall 'lie where they fall'; that the Congress, after deciding on a plan for the Nation, establish a target date ten years ahead, by which time the U.S. will have become predominantly, though not exclusively, metric; that there be a firm government commitment to this goal."

The U.S. Congress, acting on most of these recommendations, passed the Metric Conversion Act of 1975. It was signed into law by the President on December 23, 1975, and it establishes a national policy "to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system."

After almost 200 years, the United States is finally on the road to metric changeover. □

Update of U.S. Metric Activity

In Industry: Many of the United States' largest firms have made a public commitment to go metric. One of the leading sectors is the automobile industry. Many 1977 cars have dual metric/customary speedometers. Most cars are expected to be built to metric standards and specifications by 1980.

In Education: Every one of our 50 states has metric education activities underway. In 32 states, there has been formal "go metric" action taken by state legislatures and/or state school boards.

In Government: An Interstate Metric Committee has been formed by the National Governors Conference; nearly every state has appointed a representative. Several states have formed committees to guide metric conversion activities for their states.

In Daily Life: Metric consumer products are increasing. In addition to such items as 35-mm film and 500-milligram tablets of vitamin C, consumers can now buy 1-liter bottles of many soft drinks. Metric sizes of wine and distilled spirits are also beginning to appear in our stores. Many weather reporters are giving temperatures in degrees Celsius.

ON LINE WITH INDUSTRY

FIRE RESEARCH WITH THE GYPSUM INDUSTRY

When the only thing communicated between industry and government laboratories is deafening silence, trouble is ahead. So says Randall Lawson, an industrial technologist who has spent the last three years at the National Bureau of Standards doing fire research for the gypsum industry.

He describes his views this way:

"A failure to communicate can cause serious problems, especially in areas like policy development. For example, the government is developing policies to cut fire losses in this country. Research is the key, of course, because it provides the information that goes into making standards for more fire-safe materials and products. Standards that have to do with my field—building materials—can ultimately affect what kinds of materials will be used and how buildings will be designed and constructed. These standards include policy decisions that have to be realistic from both the technical and the economic standpoints. It takes a meeting of minds to bring that about, and many of the essential agreements must be reached in the laboratory."

At NBS, Lawson has been part of a cooperative effort to bring industry and government together at the critical point—the lab bench—where the synthesis of policy and technology often begins.* His experience shows how this interaction works:

"When I first came to the Bureau, NBS fire researchers Daniel Gross, Alex Robertson, and Joseph Loftus had developed a

test method for determining the heat value of building materials. That means that the method could be used to find the total amount of heat a material could release under fire conditions.

"It was going to be submitted to the National Fire Protection Association, a private standards-setting organization. NFPA—if it had adopted the method—could have used it as the standard for classifying a material to determine whether the material was suitable for a particular building application. Obviously, once issued by NFPA, the test method could have a direct impact on building codes activities.

"I saw possibilities for reducing some of the uncertainties associated with the original test. I worked with Dan Gross and the others, and we made additions that do cut down the uncertainties. Today, the method is better technically and it has been accepted by the National Fire Protection Association." (The Association adopted it in May 1976 as NFPA Standard 259.)

Lawson will return to his "parent" company, National Gypsum, in the spring. He is ending his three years at NBS by concluding two other research projects. One involves another test method, this time for the ease of ignition of building materials. It will be used to determine the relative ability of materials to ignite under what is called "low-incidence, flame-impingement conditions." A fire in a wastebasket would qualify as such a condition. Lawson and physicist William Parker of the NBS Center for Fire Research are collaborating on this method, which may be submitted to NFPA or the American Society for Testing and Materials.

The other project is an evaluation of the fire properties of the generic gypsum board products recognized in model building codes.

"The industry already knows the general characteristics of gypsum under fire conditions," says Lawson. "But the entire fire protection community needs this analysis to fill a gap in information as to the exact properties of such materials under various fire environments."

The Gypsum Association funded Lawson's three years at NBS. The Bureau gave him use of NBS facilities and access to the expertise of NBS scientists. Who benefited?

"Industry and government benefit from this cooperation; however, the public will receive the greatest return," says Lawson. "What we're talking about is fire safety. What I've done helps provide more information to the people who have something to say and do about that subject. Building code officials, managers in industry, and standards writers have more facts to go on to make buildings safer for people." □



photo by Mark Heller

* Lawson is participating in the NBS Research Associate Program and is being sponsored by the Gypsum Association, the national trade association for the gypsum industry. The Research Associate Program has brought researchers from all areas of industry to NBS labs for over 50 years to work on projects of mutual interest—for mutual benefit. For information, contact Peter de Bruyn, Room A402 Administration Building, National Bureau of Standards, Washington, D.C. 20234. Phone: (301) 921-3591.

STANDARDSTATUS

The standards activities of the National Bureau of Standards were classified by the first NBS director, Samuel Stratton, into five categories: Standards of measurement; standard values of physical constants (such as the relation between heat and mechanical energy); standards of quality (involving physical and chemical investigation of materials); standards of mechanical performance (based on the three preceding categories); and standards of practice (such as building codes).

These categories still apply to the broad, diverse standards programs of NBS, from basic research on crystal lattices that may lead to a new standard of mass to the processing of a voluntary product standard for toy safety.

THE U.S. VOLUNTARY STANDARDS SYSTEM: NBS ROLE MAY BE CHANGING

by Lawrence Eicher

Lawrence Eicher, as chief of the Standards Information and Analysis Section, is concerned mainly with the Bureau's involvement in engineering standards and product standards. The following discussion by Eicher is an assessment of recent developments in the legislative and executive branches of government that could affect NBS and its role in the voluntary standards arena.

Voluntary engineering and product standards and the private sector organizations that develop them are currently receiving a great deal of attention from Congress and the Executive Branch of the

federal government. Specifically, three separate but interrelated happenings seem to indicate that major changes in the U.S. voluntary standards systems may soon occur.

First, and potentially foremost, congressional concern with voluntary standards development and use is building. A Bill (S.3555) entitled "The Voluntary Standards and Certification Act of 1976" was introduced in the 94th Congress by Senators Philip Hart, James Eastland, and James Abourezk. This bill, which has become known as "Triple Nickles,"^{*} would involve the federal government, particularly NBS, in voluntary standards to a much greater extent than has been true in the past. For example, the Secretary of Commerce would be required to certify standards-development and product-certification bodies and would be authorized to provide financial assistance to not-for-profit standards development organizations to ensure balanced participation in standards activities and to maintain appeals bodies. (NBS is part of the Commerce Department.) Triple Nickles also contains titles related to international standardization activities and natural laboratory accreditation that, if enacted, would have a very large impact on NBS' programs in these areas. Although S.3555 did not pass, it will probably be reintroduced in the next session of Congress.

Second, the Federal Trade Commission (FTC) is nearing completion of a study on voluntary standardization and its possible anticompetitive effects. This study could result in the promulgation of FTC rules governing standards-setting procedures in the private sector.

Third, the Office of Management and Budget has recently issued a proposed Circular that will establish uniform policy for all executive branch agencies in working with commercial (non-Federal) standards-setting bodies. The proposed Circular incorporates principles developed by the Interagency Committee on Standards Policy, which is chaired by the Department of Commerce, with membership from 22 executive departments and agen-

cies. Assuming that no significant change will be made in the OMB Circular, we will have, for the first time, a uniform government-wide policy with respect to voluntary commercial standardization. To implement this new policy, DoC and many other federal agencies are already working on internal administrative orders and policy statements.

Needless to say, NBS is very much involved in a wide range of activities related to these recent events. The concerns of Congress, FTC, and OMB are directed primarily at the development of commercial engineering and product standards, an area where more than 400 NBS professionals participate on more than 1300 standards-writing committees sponsored by more than 100 private standards-writing organizations, both domestic and international. NBS' programs related to metrology and fundamental measurement standards will also be affected, though less severely, by changes in the commercial standards area.

Add to all this the country's conversion to metric, which can't be accomplished without major perturbations of the voluntary commercial standards system, and you have a hold-on-to-your-hat situation in the standards field. □

^{*}It must have been a Citizens' Band radio buff who originally dubbed S.3555 "Triple Nickles"; CB'ers refer to the 55 mph speed limits as "double nickles."

STAFF REPORTS

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SRM's for Electron Probe Microanalysis, page 26
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HIGHLY EFFICIENT LASER IONIZATION OF DENSE VAPORS ACHIEVED

A new technique for producing a dense, homogeneous column of positive ions at relatively low temperatures has a number of important potential applications. Probably foremost is the possibility of using the column as a medium for designing an ultraviolet up-converter to produce much shorter wavelengths.

Thomas B. Lucatorto, Optical Physics Building, (Room A251, Physics Building, 301/921-2031 and Thomas J. McIlrath, Optical Physics Division and Institute for Physical Sciences and Technology, University of Maryland.)

A new technique for ionizing dense vapors has been developed. A moderately high power, tunable laser is used to produce nearly 100 percent ionization of a column of 10^{17} to 10^{18} atoms with little immediate heating of the ions. Using this technique we have been able to perform the first quantitative absorption spectroscopy of a positive ion, measuring the high Rydberg series members and the

photoionization cross sections of Na^+ and Li^+ . (See fig. 1 for spectroscopic data on Na^+ .)

The first ionization experiment consisted of irradiating a 10-cm column of sodium vapor in a heat-pipe oven at 1-torr (0.13 kPa) pressure with a laser resonant on the sodium $3^2\text{S} \rightarrow 3^2\text{P}$ transition. Initially, the laser produces a large population in the 3^2P level. Subsequently, this excitation energy is efficiently converted into the production of ions. The conversion process is presently under study and apparently involves two stages: in the first part of the laser pulse, direct multiphoton ionization creates a small ($\approx 10^{11} \text{ cm}^{-3}$ ion-electron pairs) density of free electrons in addition to a large (10^{15} cm^{-3}) population of excited states; in the ensuing collisions between the free electrons and the excited states, the electron has a high probability of de-exciting the atom and carrying away the quantum of energy ("super-elastic" collisions). The super-elastic collisions provide a coupling between the laser energy and the electron energy, causing the electrons to heat up considerably and produce further excitation and ionization. The entire ionization

process can be driven to practically 100 percent completion and has an observed energy efficiency in the present experiments of about 10 percent, i.e., about 1 in 10 of the photons from the 1-MW laser go into ionizing the atoms.

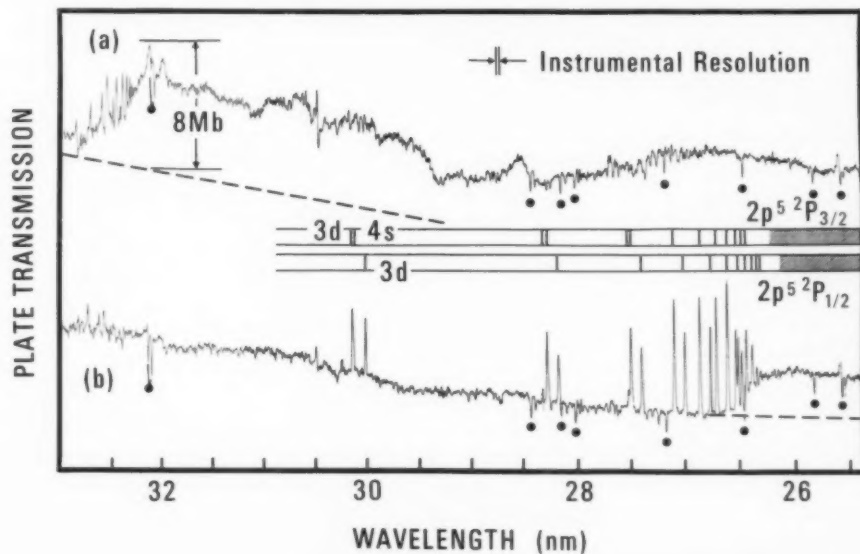
Our work up to now has focused on the far UV absorption spectroscopy of the ions produced. For this purpose the ions created by the laser pulse are probed by a simultaneous pulse of UV continuum radiation. A 3 meter grazing incidence spectrograph disperses the continuum radiation after it has passed through the ions so that the ion absorption spectra can be studied. Since the heat-pipe oven confines a known amount of atoms and the ionization can be made close to 100 percent efficient, quantitative cross section measurements can be made on the ions.

The spectroscopic apparatus (see fig. 2) consists of the laser, which produces the ion column, and the pulsed UV source and spectrometer, which produce the absorption spectra. We intend to investigate the nature of the ionization mechanism by measuring the column density of the atomic and ionic states as a function of

Figure 1—SPECTROSCOPIC DATA ON SODIUM IN THE WAVELENGTH RANGE 32 → 26NM.

The ordinary neutral ground state sodium absorption (laser off). The feature at approximately 32 nm represents an 8 megabarn (Mb) increase in cross section over the background of the neutral ground state population. The features represented by the solid dots are emission lines associated with the background continuum source.

The absorption of the laser irradiated sodium. Notice that the Mb feature at 32 nm is practically gone, a sign that less than 10 percent of the sodium remains in the neutral ground state. The new features observed, which are labeled by the bar graph above the spectrum, represent the neon-like Na^+ Rydberg series. The sudden jump in cross section at 26.3 nm represents the onset of the photoionization of Na^+ to Na^{++} .



time after the initiation of the laser pulse and as functions of laser energy, of laser tuning, of initial atomic density, and of buffer gas pressure. We are also planning to ascertain the selectivity of the process by mixing two or more atomic vapors together and tuning to a resonance line of one of the atoms.

The NBS experimental program should provide information relevant to four areas of applied research.

1) The unexpected, efficient laser ionization observed in sodium and lithium is a fundamental part of the interaction of intense resonant radiation with dense vapors. Several laser isotope separation schemes involve exactly this resonant interaction. It is possible that, under certain circumstances, the laser ionization associated with the resonant interaction can destroy some of the selectivity or produce large losses in the system. To minimize or prevent such adverse processes, a detailed knowledge of the ionization mechanism is needed.

2) If the technique can selectively ionize one component of a multi-component mixture, it will allow the study of the interaction between the ionized compo-

nent and the neutral species. Such a technique will open up a new domain in the field involving the chemical reactions between ions and neutrals, with important consequences to isotope separation techniques, chemical synthesis, and studies of ion-neutral reaction processes.

3) Plasma physicists have been able to measure plasma recombination rates only under a limited range of conditions. The new method can produce complete ionization at pressures from several tenths of a torr to several torr (about 0.05 to 0.5 kPa) apparently without raising the ion temperature significantly. Planned studies of the time evolution of this unusual plasma will lead to a more detailed understanding of plasma recombination processes.

4) The generation of tunable, laser-like UV radiation has been achieved through *four-wave parametric up-conversion** in atomic vapors. At present there are experimental difficulties in generating high powers of UV and generating UV below 50 nm. The NBS-University of Maryland experiments can yield important information relevant to both these problems. First of all, we have shown that intense lasers can

produce non-linear processes which ionize the atomic vapor, thereby causing a loss of energy to the four-wave process. These non-linear processes should be studied to shed some light on the loss mechanisms. Secondly, the parametric up-conversion in a column of ions can lead to improved efficiencies for generating very short wavelengths since the energy spacings and photoionization limit in ions are much greater than in the associated neutral species. □

*When one or several intense beams of radiation interact with matter, non-linear processes can occur which produce harmonics of the fundamental frequencies and various mixtures (sums and differences) of the frequencies in the various beams. The most familiar application of such non-linear mixing occurs in the laser doublers, which are crystals such as ADP and KDP having a large second-order polarizability. Atomic vapors can also provide a medium for effective non-linear mixing, but because of a certain symmetry which applies to the vapor case, only the third, fifth, and higher odd orders contribute. The third-order mixing of three laser frequencies (e.g., $3w_1$ or $2w_1 + w_2$ or $w_1 + w_2 + w_3$) is called four-wave parametric up-conversion. The "fourth wave" is the frequency produced by the mixing (e.g., $w_4 = 3w_1$, or $w_4 = 2w_1 + w_2$, or $w_4 = w_1 + w_2 + w_3$).

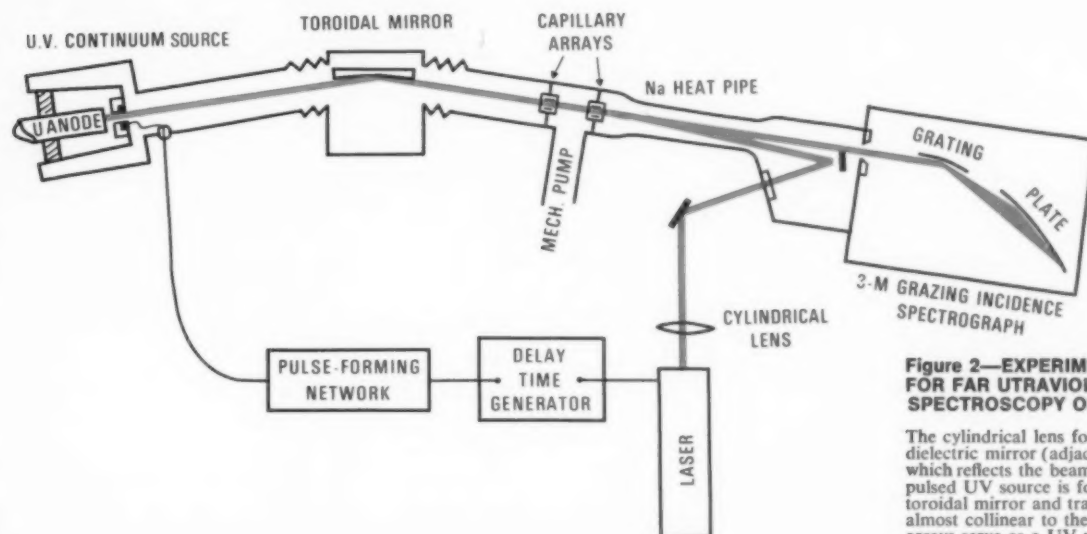


Figure 2—EXPERIMENTAL APPARATUS FOR FAR ULTRAVIOLET ABSORPTION SPECTROSCOPY OF Na.

The cylindrical lens focuses the laser onto a dielectric mirror (adjacent to the spectrograph slit) which reflects the beam through the heat pipe. The pulsed UV source is focused on the slit by the toroidal mirror and traverses the sodium on a path almost collinear to the laser beam. The capillary arrays serve as a UV window, separating the high vacuum of the UV source from the heat-pipe oven.

A WINNING INVENTION: THE CEREBELLAR MODEL ARITHMETIC COMPUTER

This computer system, known as CMAC, was chosen by *Industrial Research Magazine* as one of 100 most significant industrial products developed in 1976.

James S. Albus, Office of Developmental Automation and Control Technology, A130 Technology Building, 301/921-2381.

CMAC is a memory device with a range of applications: First, it reduces a significant new neurophysiological theory to a mathematical model of sufficient precision to make quantitative predictions in the study of behavior, motor development, and learning disabilities. Second, it is a new technique of computer memory management which makes practical the real-time computation of a large class of important multivariate functions by table look-up. Third, it is a device which can be implemented with sufficiently inexpensive technology to make its use in servo control systems economical for a wide variety of industrial applications.

CMAC computes by transforming each input variable into a set of intermediate variables which are then combined to select a set of weights from memory. These weights are summed to produce an output. The value of the output for every value of the inputs is determined by the weights. CMAC uses a distributed storage technique to accomplish this in a memory of practical size. It thus computes mathematical functions, not by solving equations, but by table look-up.

Table look-up and interpolation is, of course, a commonly used technique for functions of one to three variables. For example, trigonometric functions are often computed by table look-up and interpolation rather than by numerical solution of formulae. However, for functions of four or more variables, conventional table look-up techniques become impractical because of the extraordinary memory requirements. If there are N variables, each of which can assume R distinct values, then conventional storage methods require R^N table entries. CMAC, however, can store an important class of control functions using only $R2^N$ table entries. This is a significant saving for large N and makes practical the storage of eight to

ten variable functions ($R \leq 32$) in a computer memory of reasonable size.

The CMAC storage algorithm results in a memory device which exhibits most of the elements of learning, generalizing, associative recall, and context-sensitive decision making normally observed in animal and human conditioned reflexes. Since CMAC is abstracted from known anatomical and physiological properties of brain tissue, it thus becomes an attractive model for insect, animal, or human behavior. It makes possible the formulation of quantitative theories of motor coordination and development, learning disabilities, and speech understanding and generation.

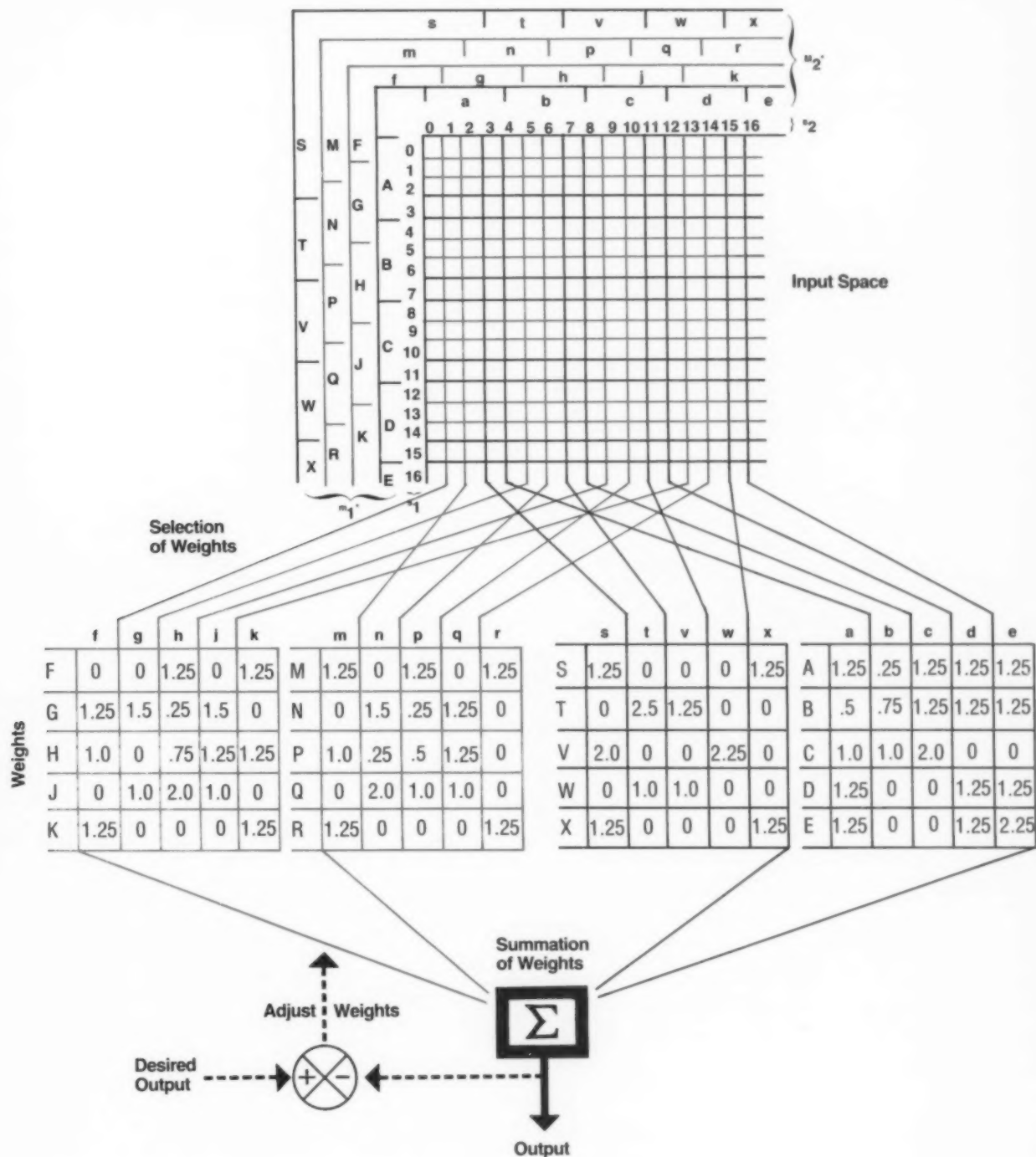
CMAC also has many potential uses as a servo control computer, a coordinate transformer, or a sequence generator for industrial robots and machine tools. It may be used for continuous flow industrial processes or on high performance aircraft to optimize control system performance over a wide range of operating conditions. Eventually, CMAC modules may be connected in a hierarchy to produce autonomous sensory-interactive goal-directed behavior in remote systems for sea-bed or planetary exploration. □

Figure 1—SAMPLE COMPUTATION

INPUT VARIABLES	VARIABLES INTERMEDIATE	WEIGHTS	OUTPUT
7	→ {B, H, P, V}	Bc = 1.25 Hi = 1.25	SUM = 3.75
10	→ {c, i, q, v}	Pq = 1.25 Vv = 0	
INPUT S_1 = 7 MAPS INTO THE SET m_1^*	= {B, H, P, V}	THESE TWO SETS COMBINE TO DEFINE THE FOUR WEIGHTS	THESE WEIGHTS ARE SUMMED TO PRODUCE THE OUTPUT
INPUT S_2 = 10 MAPS INTO THE SET m_2^*	= {c, i, q, v}	Bc, Hi, Pq, Vv	

As either input changes by one resolution element, one weight drops out and another takes its place. In the example above, if the input (7, 10) changes to (7, 9) the weight Pq = 1.25 drops out to be replaced by Pp = -0.5. Thus the output changes from 3.75 to 2.00.

Figure 2—TWO INPUT VARIABLE CMAC



NEUTRON DIFFRACTION FOR NDE BEING STUDIED

Neutron diffraction studies conducted by NBS and Picatinny Arsenal have yielded promising results for Nondestructive Evaluation applications.

Chang S. Choi and Henry J. Prask, Picatinny Arsenal and Reactor Radiation Division, A116 Reactor Building (301) 921-3634 and John J. Rush Reactor Radiation Division, A106 Reactor Building.

Working at the NBS reactor, we have made use of the great penetrating power of neutrons (relative to x-rays of comparable wavelength) to nondestructively measure bulk grain orientation within machined metal components. Our initial studies have concentrated on the determination of grain orientation within copper cones (wall thickness 3 mm) used in shaped-charge munitions.

Although preferential grain orientation within the cone is known to be important for optimizing performance in this type of ammunition, no nondestructive testing technique has been available to measure bulk grain orientation so that a quantitative correlation of grain orientation with performance could be established. Studies now completed have shown that the needed information is easily obtainable by neutron diffraction.

Future studies in this area will be aimed at the determination of grain orientation as a function of depth, obtained by measuring diffracted intensities from a given reflecting plane for different neutron wavelengths.

In addition to continuing applications for shaped-charge ammunition, the use of neutron diffraction for nondestructive grain orientation determination has potential usefulness wherever this information is needed for bulk materials, for very heavy elements, and for characterization of coated substrates. □

STANDARD REFERENCE MATERIALS FOR ELECTRON PROBE MICROANALYSIS

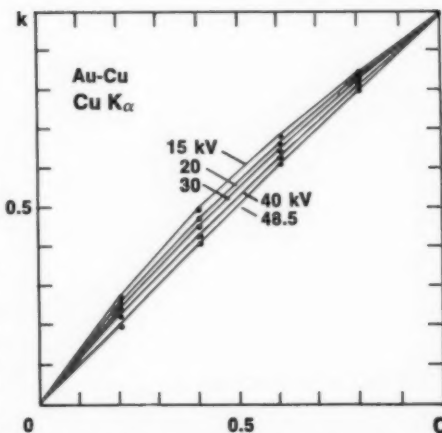
Six Standard Reference Materials (SRM's) and two Research Materials (RM's) have been specifically prepared for electron probe microanalysis (EPMA), and a number of other SRM's have considerable potential usefulness in that area.

EPMA is based on determining the x-ray flux emitted by an unknown sample relative to a suitable standard. Such standards can be either pure elements, which are the most readily available, or intermediate compositional standards.

All standards must be homogeneous at micrometer levels of spatial resolution, stable with respect to time and environment, properly prepared for EPMA and carefully characterized by independent techniques. Homogeneity is the most stringent requirement and must be carefully checked with line scans, area scans, and point counting.

The six SRM's listed in Table 1 meet all of these requirements and are certified for use as EPMA standards.

The two NBS-RM's were developed for both EPMA and secondary ion mass spectrometry (SIMS). These are homogeneous, vitreous solids containing known, low-concentration additions of several elements that should be useful in the analysis of complicated unknowns.



Analytical calibration curves for the copper, K_{α} line in gold-copper binaries (SRM 482) at various operating voltages. Background-corrected intensity ratios, k , are plotted vertically and mass fractions of copper, C , horizontally. Similar curves can be obtained for gold-silver binaries (SRM-481).

Other SRM's that have been used or that are potentially useful in electron probe microanalysis are listed in Table 2; however, none of these has been specifically certified for this purpose. Therefore, all but the pure elements and the two standard reference materials with asterisks should be checked for microhomogeneity before use.

For ordering information, write the Office of Standard Reference Materials, B311, Chemistry Building, or call 301/921-2045. □

Table 1

SRM	Type	Form	Elements (Nominal wt %)
478	Cartridge Brass	Cube & Cylinder	Cu-73; Zn-27
479	Fe-Cr-Ni Alloy	Wafer	Fe-71; Cr-18; Ni-11
480	Tungsten-20% Molybdenum	Wafer	W-78; Mo-22
481	Gold-Silver	Six Wires	Au-100; 80; 60; 40; 20; 0 Ag-0; 20; 40; 60; 80; 100
482	Gold-Copper	Six Wires	Au-100; 80; 60; 40; 20; 0 Cu-0; 20; 40; 60; 80; 100
483	Iron-3% Silicon	Platelet	Fe-97; Si-3
RM 30	Glasses for Microanalysis	Slices	10 Compositions of Various Oxides
31	Glass Fibers for Microanalysis	Fibers	10 Compositions of Various Oxides

Table 2

SRM	Form	Type
44f	Aluminum (Pure element)	Rod
45d	Copper (Pure element)	Rod
49e	Lead (Pure element)	Bar
*461	Steel, Low Alloy A	Rod
462	Steel, Low Alloy B	Rod
*463	Steel, Low Alloy C	Rod
464	Steel, Low Alloy D	Rod
465	Ingot Iron E	Rod
466	Ingot Iron F	Rod
468	Steel, Low Alloy H	Rod
661	Steel, AISI 4340	Rod
662	Steel, AISI 94B17 (mod)	Rod
663	Steel, Cr-V (mod)	Rod
665	Electrolytic Iron (Pure element)	Rod
680	Platinum (Pure element)	Wire
682	Zinc (Pure element)	Circular Segment
685	Gold (Pure element)	Rod, Wire
741	Tin (Pure element)	Circular Segment
1134	Steel, High Silicon	Disk
1135	Steel, High Silicon	Disk

*NBS Misc. Publ. 260-3 and 260-10 describe the characterization of SRM's 461 and 463, respectively, by quantitative metallography and electron probe microanalysis.

HUMIDITY CALIBRATION SERVICE EXTENDED TO BROADER TEMPERATURE, PRESSURE RANGE

NBS has completed a new precision humidity generator to extend its calibration service for humidity sensors and standards to ambient temperatures up to 80 °C. The new generator also enables NBS to provide calibration services at various ambient pressures.

Arnold Wexler and Saburo Hasegawa, Heat Division, A105 Physics Building, (301) 921-2794.

The generator saturates a stream of gas with water vapor at a high pressure and then expands the gas to produce the desired humidity, temperature, and pressure.

EXTENDED CALIBRATION SERVICES AVAILABLE FOR LOW VACUUM GAGES

Effective this month, manufacturers and users of vacuum gages at pressures as low as 1 pascal can send such instruments to NBS for calibration.

Peter L. Heydemann Heat Division, A 149 Metrology Building, (301) 921-2121.

NBS is offering calibration services for low vacuum gages such as capacitance diaphragm manometers over the range from 1 to 10 000 Pa (0.01 to 100 torr). The development of a new standard, ULTIMA II, allowed us to expand the lower limit of the calibration range by over three decades below the previous lower limit of 2 kPa. ULTIMA II is a very precise ultrasonic interferometer mercury manometer. The accuracy of the standard is 0.01 percent of the reading plus 0.2 Pa.

Various gases including helium, argon, nitrogen, and hydrogen can be used as

pressure transmitting fluids. A calibration report listing the applied pressure, the gage reading, coefficients of suitable polynomials fitted to the data, tables of corrections, and statements of uncertainty will be issued for each device calibrated.

This expansion of the calibration range, which now covers almost nine decades of pressure from 1 Pa to 700 MPa, was prompted by requests for calibrations in the low vacuum range and by the results of a survey conducted by NBS of the need for and availability of vacuum calibrations.

Applications for accurate measurements in the low vacuum range are found in many industries, particularly the instrumentation, chemical, nuclear, automotive, aeronautical, and petroleum industries. The development of the new standard was sponsored in part by the U.S. Navy and Air Force in support of their flight instrumentation calibration program.

Work is underway at NBS to expand the calibration range to pressures below 0.1 Pa with a new manometer now under construction. □

Calibrations are provided over a relative humidity range from 3 to 98 percent for ambient temperatures from -60 to 80 °C (an increase of 40°) and at ambient pressures from 5 to 200 kilopascals (1/20 to 2 atm). This is equivalent to a nominal dew/frost point range of -80 °C to 80 °C. The estimated maximum error (for three standard deviations) over most of the range is 0.2 percent relative humidity or 0.04 °C in dew/frost point.

A large variety of humidity measuring instruments are used widely throughout industry, science, commerce, and government for monitoring and controlling the water vapor content of an environment, process, or product in fields as diverse as meteorology, air conditioning, drying, electronics, refrigeration, storage, food processing, textile and paper manufacturing, and communications. Most of these

are purely empirical and require careful calibration if measurements are to be made with a high degree of accuracy. The NBS service provides for calibration against the ultimate national standard.

Instruments suitable for use as secondary or transfer standards, such as dew point hygrometers, electric hygrometers, psychrometers, coulometric hygrometers, and piezoelectric hygrometers, will be accepted for calibration. Sensors that are used as humidity probes can be submitted for test, evaluation, and characterization of performance.

A calibration report is furnished, giving the test procedure, values of calibration, and the differences between the correct values and measured values. Tests are normally done with atmospheric air but can be performed using any gas available in compressed gas cylinders. □

CONFERENCES

For general information on NBS conferences, contact Sara Torrence, NBS Office of Information Activities, Washington, D.C. 20234, 301/921-2721.

ENERGY CONSERVATION SYMPOSIUM

A Symposium on Thermal Analysis, Human Comfort, and Indoor Environments will be held February 11, 1977. This meeting will bring together leading scientists, engineers, government officials, architects, physiologists, and manufacturers interested in how new energy conservation modifications to buildings will affect human comfort and what type of measurement technology will be required to assess these effects.

The symposium is prompted by the increasing emphasis on energy conservation practices in existing buildings as well as new building designs that emphasize energy conservation. Some of the practices have no effect on the thermal comfort of occupants. However, others, such as limiting the use of both cooling and installed capacity of heating, ventilating, and air conditioning equipment, lower thermostat settings in winter, higher thermostat settings in the summer and eliminating climate control in halls, entryways, and storerooms may have an adverse effect on occupants.

All sessions will be held in Lecture Room A, Administration Building, at the National Bureau of Standards, Gaithersburg, Maryland. The meeting will begin at 9:30 a.m. (registration at 9:15 a.m.), and end at approximately 5:15 p.m.

Papers to be Presented

Aspects of Indoor Environments: Tolerable vs. Comfortable Thermal Environments

E. R. Buskirk

Thermal Comfort in Indoor Environments

P. O. Fanger

Radiation Measurement for Thermal Comfort Assessment

L. G. Berglund

Experimental Analysis of Thermal Acceptability

R. R. Gonzalez

The Physical Determination and Rating of Environments for Human Thermal Comfort

T. H. Benzinger
Industrial Heat Stress Monitoring
F. N. Dukes-Dobos
Measurement Techniques for the Heat Stress Environment Aboard Naval Ships
G. Ponton

Current Concepts of the Physiological Basis for Comfort

Ralph F. Goldman

The Use of Modeling Human Response in the Analysis of Thermal Comfort of Indoor Environments

N. Z. Azer and S. Hsu

Effect of Energy Conservation Guidelines on Comfort, Acceptability and Health

A. Pharo Gaggee and Ralph H. Nevins
Energy Conservation Strategies in Buildings and Their Relation to Needed Physiological Research

T. Kusuda and J. E. Hill

For further information contact Dr. B. W. Mangum, B122 Physics Building, 301/921-2098 or Dr. J. E. Hill, B104 Building Research Building, 301/921-3503. □

FLOW MEASUREMENT SYMPOSIUM

ERRORS in open channel and closed conduit flow measurement, their sources, assessment, and resolution will be discussed in a symposium on February 23 and 24. Reliable and accurate flow measurements are becoming increasingly important to the economic and technological aspect of energy generation and conservation, industrial process control, and air water quality control. The proliferation of new metering techniques and increased demands on existing techniques, coupled with greater emphasis on economic and environmental accountability provide the impetus for this symposium.

Technical areas for symposium consideration include measurement system influences on meter performance, instrument installation errors in the field, inaccuracies in tabulated data for physical properties of fluids, errors in published meter coefficient data, effects of fluid contaminants, effects of velocity distribution or turbulence on instrument performance, and related topics. This meeting proposes

to provide a forum for identifying additional sources of errors in flow measurement, formulating error analysis techniques and recommending techniques for resolving uncertainties. Additionally, it is expected to provide the stimulus for cooperative industry-government activities for reducing uncertainties in all phases of open channel and closed conduit flow.

The symposium will consist of two day-long sessions with presentations by each speaker to be followed by discussion periods between the audience and speakers. A combination of invited lectures and contributed technical papers will be presented.

For further information contact: William C. Haight, Room 105 Fluid Mechanics Building, 301/921-3681. □

NEUTRON STANDARD SYMPOSIUM

AN international specialists symposium on "Neutron Standards and Applications" will be held March 28-31, 1977. The purpose of the meeting will be to assess progress in neutron standards, to review the spectrum of applications of neutron standards and to establish direction for future work.

The last meeting on neutron standards was held nearly seven years ago at the Argonne National Laboratory. The meeting successfully covered a broad range of neutron standards topics and the proceedings have been a valued guide to those involved in improving or using neutron standards. It helped to focus attention on neutron standards measurement problems and to stimulate more aggressive activity in this field. International interest and cooperation in this field was also stimulated by IAEA-sponsored panel on Neutron Standard Reference Data convened November 20-24, 1972, in Vienna, Austria. This meeting focused strongly on standards for the fission reactor core and for shielding design which have been the areas of greatest impact on neutron standards.

The International Nuclear Data Committee of the IAEA, recognizing the broad-

er range of application and need for neutron standards, has recommended that the scope of the next meeting be broadened to include the full spectrum of neutron standards. The program of this meeting will continue the strong emphasis on core and shielding differential nuclear data standards, but will also include emphasis on integral neutron standards and on a number of fledgling topics that probably will receive greater attention in the future.

As neutron-based technology continues to mature and expand, the role of neutron standards assumes even greater importance. The slow progress in recent years in further improving the accuracy of neutron data for reactors has focused attention on the central role which neutron standards will play in this area. Neutron personnel dosimetry has greatly increased in importance as the more stringent health and safety standards become more costly. For cancer therapy with neutrons, small uncertainties in neutron dose might spell the difference between failure and success. Neutron-induced radiation damage to fusion system materials is providing new challenges for neutron dosimetry in the higher energy ranges. Absolute neutron source strength continues to play a major role in basic science and in technology. All of these areas will be examined in some detail.

The Program Committee has attempted to plan well focused sessions on various topics. Therefore, the solicitation of talks is by invitation with rather specific requests of speakers in regard to content and emphasis.

Preliminary Session Topics

- I ${}^6\text{Li}$ (n,α)
 - Data base on ${}^7\text{Li}$ System
 - Angular distribution
 - R-matrix analysis
 - ${}^6\text{Li}$ glass problems
 - Instruments

(The session on ${}^6\text{Li}$ was planned for the program committee by the Nuclear Energy Agency Nuclear Data Committee as a consequence of its strong interest in

this standard and its associated uncertainties.)

For further information, European scientists should contact: Dr. Horst O. Liskien, 014/58.94.21, Central Bureau Voor Nucleaire Metingen, B-2440 Geel, Steenweg Naar Retie, Belgium. Other participants should contact: Dr. Charles D. Bowman or Dr. Allan D. Carlson, B119 Radiation Physics Building, 301/921-2234. □

CONFERENCE CALENDAR

February 11

SYMPOSIUM ON THERMAL ANALYSIS, HUMAN COMFORT, AND INDOOR ENVIRONMENTS, NBS, Gaithersburg, MD; sponsored by NBS; contact: Dr. B. W. Mangum, B122 Physics Building, 301/921-2098 or Dr. J. E. Hill, B104 Building Research Buildings, 301/921-3503.

February 23

FLOW MEASUREMENT SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS; contact: William C. Haight, 105 Fluid Mechanics Building, 301/921-2681.

March 28-31

NEUTRON STANDARDS SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS, contact: European scientists Dr. Horst O. Liskien, 014/58.94.21, Central Bureau Voor Nucleaire Metingen, B-2440 Geel, Steenweg Naar Retie, Belgium. Other participants contact: NBS, Dr. Charles D. Bowman or Dr. Allan D. Carlson, B119 Radiation Physics Building, 301/921-2234.

April 13-15

10TH ANNUAL SYMPOSIUM ON THE INTERFACE OF COMPUTER SCIENCE AND STATISTICS, NBS, Gaithersburg, MD; sponsored by NBS; contact: David Hogen, A338, Administration Building, 301/921-2315.

May 10-12

SEVENTH SYMPOSIUM ON THERMO-

PHYSICAL PROPERTIES, NBS, Gaithersburg, MD; sponsored by NBS and the American Society of Mechanical Engineers; contact: Ared Cezariliyan, Room 124, Hazards Building, 301/921-3687.

May 16-18

CONFERENCE ON CORROSION OF METAL IN BUILDINGS, NBS, Gaithersburg, MD; sponsored by NBS; contact: G. Frohnsdorff, B350 Building Research Building, 301/921-3458 or J. Kruger, B252 Materials Building, 301/921-2094.

May 19

TRENDS AND APPLICATIONS SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS and IEEE Computer Society; contact: Marshall Abrams, B212, Technology Building, 301/921-2601.

June 2

SYSTEMS AND SOFTWARE: OPERATIONAL RELIABILITY AND PERFORMANCE ASSURANCE; 16th Annual Technical Symposium, NBS, Gaithersburg, MD; sponsored by the Association for Computing Machinery, Washington, D.C. chapter, and NBS. Contact: Stewart Katzke, A265, Technology Building, 301/921-3861.

June 6-9

CONFERENCE ON ULTRASONIC TISSUE CHARACTERIZATION, NBS, Gaithersburg, MD; sponsored by NBS; contact: Melvin Linzer, A329 Materials Building, 301/921-2858.

August 9-11

FIFTH SYMPOSIUM ON THE SIMULATION OF COMPUTER SYSTEMS, NBS, Gaithersburg; sponsored by NBS and the Special Interest Group on Simulation of the Association for Computing Machinery; contact: Paul Roth, B250, Technology Building, 301/921-3545.

September 21-23

SYMPOSIUM ON ROOFING TECHNOLOGY, NBS, Gaithersburg, MD; sponsored by NBS and the National Roofing Contractors Association; contact: Robert G. Mathey, B348, Building Research, 301/921-3407.

PUT A DAMPER ON NOISE— PREVENT DEAFNESS

Quieting, A Practical Guide To Noise Control, Berendt, R. D., Corliss, E. L. R., and Ojalvo, M. S., Nat. Bur. Stand. (U.S.) *Handb.* 119, 163 pages (July 1976), SD Catalog No. C13.11:119, \$5.10.

PRACTICAL solutions to controlling noise at the source and along its path of travel have been studied by Raymond D. Berendt and Edith L. R. Corliss of NBS and Morris S. Ojalvo of the National Science Foundation. Their study was undertaken because the most effective way to avoid health hazards of noise is to protect the listener from exposure to prolonged or loud noises. They pointed out in their recent publication, *Quieting, A Practical Guide to Noise Control*, that persons in noisy occupations and those with noisy avocations generally have various degrees of permanent hearing loss. Avocations with the more devastating consequences are rock music, target shooting, and snowmobiling. Hearing loss due to gunshot noise in warfare is very prevalent.

Noise damage to hearing is an insidious process. The immediate effects do not always indicate the ultimate results of exposure. Exposure to mildly excessive noise level results in a temporary desensitization of the ear, the so-called "temporary threshold shift," a transitory loss of the ability to detect faint sounds. Noises likely to cause this condition are encountered during subway rides and airplane trips. Some degree of temporary threshold shift may be detectable even on the day following exposure, but recovery can be complete.

This pattern of threshold rise and recovery may go on through a number of cycles without any further evidence of damage, and then there may be a sudden failure to make complete recovery. This permanent effect is called "noise-induced permanent threshold shift" (NIPTS). The damage is located at the auditory nerve with serious consequences.

After exposure to sound levels of 85 dB and above for lengthy periods of time, a

significant number of persons will suffer permanent hearing loss; this degree of exposure essentially doubles the incidence of hearing loss beyond what would occur from mischance and disease in the course of aging. Since there is some reason to believe that 80 dB represents the point from which the damage risk begins to be significant, it is obviously a good idea to avoid continuous exposure to any levels above 80 dB for any length of time comparable to a working day, and to wear ear protection if exposure is necessary.

Exposure to noise of 70 dB or more induces symptoms of nervous stress; during sleep the sound level need only exceed 55 dB to produce changes resembling the waking stress for 70 dB. The importance of avoiding exposure to high or stressful noise levels motivated the researchers to summarize in detail the basic principles of noise reduction and to give numerous practical suggestions for noise control.

All the protective measures possible to suggest, the researchers point out, are palliative. It is clear that the best procedure is to cut off excess noise at the source. The scientists, therefore, made a study of the sound pressure level in dB for common sources of noise and plotted their dominant frequencies and levels as typically heard by an observer. They also plotted the maximum daily exposure to a certain level of noise allowed for a person to remain below damage-risk limits. A person should be exposed no longer than 20 minutes daily to the sound of an automobile horn and should be limited to 7 minutes daily exposure to an emergency siren or jet plane flying by.

One of their studies concerned the reduction of noise in the home. Noise control in the home is possible by reducing the travel or transmission of both airborne noise and structureborne noise, whether generated by sources inside or outside the house. Airborne sound waves are transmitted as pressure fluctuations in the open air or in buildings along continuous air passages such as corridors, doorways, staircases, and duct systems. Airborne

noise transmission can be reduced by installing a wall or floor structure in its path. Decrease of airborne or structureborne noise may be achieved by padding and draperies. In some cases, installing a gypsum board ceiling suspended on resilient channels increases impact isolation.

Structureborne noise occurs when wall, floor, or other building elements are set into vibratory motion by direct contact with vibrating sources such as mechanical equipment or domestic appliances. To control appliance noise the authors describe how to isolate an appliance to prevent vibration from being transmitted. They recommend use of pads of resilient materials under the corners of heavy appliances and isolation of the appliances from the wall.

Their detailed analysis of how to reduce noise is discussed in various chapters in their handbook, and not only covers noise control in the home or apartment, but also includes suggestions for noise control in an office or school and while traveling. Numerous figures and diagrams illustrate ways of isolating noisy appliances and other equipment to reduce noise, how to insulate a building for noise control, and how to furnish an office or school room for privacy and noise control. □

Analytical Chemistry

LaFleur, P. D., Ed., *Accuracy in Trace Analysis: Sampling, Sample Handling, Analysis. Proceedings of the 7th Materials Research Symposium Held at the National Bureau of Standards, Gaithersburg, Md., October 7-11, 1974*, Nat. Bur. Stand. (U.S.), Spec. Publ. 422, Vol. I, 645 pages, Vol. II, 636 pages, (Aug. 1976) SD Catalog No. C13.10:422/Vol. I and II, \$20 per 2-part set.

Building Technology

Fennes, S. J., Rankin, K., and Tejuja, H. K., *The Structure of Building Specifications*, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 90, 83 pages (Sept. 1976) SD Catalog No. C13.19/2:90, \$1.45.

Computer Science and Technology

Berg, J. L., Ed., Canning, R. G., Adams, D. L., Berner, R. W., Dodd, G., Gall, R. M., and Trigg, C. D., *Data Base Directions. The Next Step. Proceedings of the Workshop of the National Bureau of Standards and the Association for Com-*

OF THE NATIONAL BUREAU OF STANDARDS

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Linden, T. A., *Operating System Structures to Support Security and Reliable Software*, Nat. Bur. Stand. (U.S.), Tech. Note 919, 51 pages (Aug. 1976) SD Catalog No. C13.46:919, \$1.25.

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NEWS BRIEFS

BATTERIES IN COLD STORAGE. Refrigeration will extend the storage life of your dry cells and flashlight and radio batteries, according to NBS electrical engineer Woodward Eicke. As a general rule-of-thumb, the rate of a chemical reaction is cut in half for every 10 °C drop in temperature. Slowing down the reactions that cause batteries to go "dead" can keep them "alive" for two to three years beyond normal shelf life. Batteries should be wrapped in plastic (not metal foil) to protect them in the refrigerator and warmed to room temperature before using.

DEVELOPMENTS IN COMPUTERIZED VOTING. When Minnesotans went to the polls in the recent presidential election, their state was prepared with new rules for use of computerized election equipment and vote-tallying computer programs. The regulations were based largely on Effective Use of Computer Technology in Vote Tallying, a National Bureau of Standards report (NBSIR 75-687) by Roy G. Saltman. State officials also benefitted from direct consultations during a visit by Saltman. Minnesota's innovations are being widely observed as a harbinger of what Lucia Mouat, in the Christian Science Monitor, has called a "quiet but dramatic revolution under way in the mechanics of running elections."

PLAY IT SAFE WITH PLAYGROUND EQUIPMENT. Parents in the market for swing sets and jungle gyms should look for labels that say: "Conforms to PS 66-75." These labels indicate that the equipment meets the safety requirements of a Commerce Department Voluntary Product Standard. The standard also covers items such as merry-go-rounds, dome climbers, and kiddie rockers intended for children between two and 10 years of age. NBS processed the standard at the request of the National Association of Children's Home Playground Manufacturers, Inc.

HELP FOR HOMEOWNERS. People looking for ways to reduce their heating bills can find the answers in a handy guide from NBS and the Federal Energy Administration. The guide is called "Making the Most of Your Energy Dollars in Home Heating and Cooling" and is available for 70 cents from Consumer Information, Pueblo, Colo. 81009.

FCC APPROVES TV CAPTIONS FOR THE DEAF. A December 10 ruling by the Federal Communications Commission will allow television networks to broadcast "closed" program captions for the deaf. Closed captions, which only appear on the screen when a special decoder is attached to the television receiver, are the result of a system developed by the NBS Time and Frequency Division in 1971 to distribute accurate time and frequency information over network television.

NEXT MONTH IN

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Where does the talk stop and the action start when it comes to alleviating our costly "energy crisis"? One place is Manchester, New Hampshire, where the General Services Administration is operating a newly built, energy-efficient office building. The February issue of DIMENSIONS will discuss the Norris Cotton Building and how it has been designed as a "living laboratory" to test and demonstrate that energy conservation can save dollars and fuel.

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